

THE STATUS OF THE SQUID FISHERIES IN THE UNITED STATES OF AMERICA

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I. INTRODUCTION

The world's squid fisheries have risen to prominence shortly after the end of the Second World War, led by the rapid development of the fisheries by Japan. The Japanese production of squid reached a high of 758,500 tons in 1968 and has fluctuated between 400,000 and 600,000 tons annually (FAO 1954-80). The catch in 1979 was 512,000 tons. Other countries, notably Spain and Italy, began increasing their catches in the 1950's and with the entry of the Republic of Korea in 1953 and the U.S.S.R. in 1964 the world production of squid has increased from about 100,000 tons prior to the war to over 1 million tons in 1979.

A good portion of the increase in squid production has come from foreign vessels fishing off the Atlantic and Pacific coasts of the United States of America. Unfortunately, U.S.A. fishermen have not adequately participated in exploiting the squid resources within their own waters. Recently a great deal of interest has been generated in the U.S.A., particularly in the New England and Middle Atlantic States area, for the development of a domestic squid fishery. This report presents the status of the U.S.A. squid fisheries as they exist today.

II. SPECIES OF SQUIDS IN WATERS OF THE UNITED STATES OF AMERICA

A. Eastern United States of America and Gulf of Mexico

The waters off the eastern U.S.A. and the Gulf of Mexico are rich in species of cephalopods but only a few are either being harvested or considered of potential commercial value. These include:

Loligo pealei.—This is the "common" or long-finned squid of eastern North America. It occurs in most areas of the continental shelf from off New England through the Gulf of Mexico and has been reported from various scattered areas in the Caribbean. The young remain in coastal waters until fall (mid-November), with heavy aggregations appearing off the continental shelf during the cool season from November to March (Rathjen 1973). It attains a mantle length of about 20 cm (Okutani 1977), and is the object of international commercial fishing.

Loligo plei.—This is the arrow squid of tropical waters. It has a wide distribution in the western Atlantic from Cape Hatteras to Florida, the Gulf of Mexico, Caribbean Sea, and the northern coast of South America. It is a medium squid attaining a length of about 35 cm (Okutani 1977). It is slender and not as heavy as L. pealei. It occupies a mid-continental shelf range, generally from 20 to 75 m (Rathjen et al. 1979).

Lolliguncula brevis.—This is the "thumbstall" or brief squid of the Atlantic coast of the U.S.A. It occurs from Delaware southward through the Gulf of Mexico and along the coast of South America to the southern border of Brazil (Voss 1973). It is a short-bodied, heavy squid, very meaty and ideal for canning, with adults averaging 80 mm in mantle length in males and 100 mm in females. It was originally taken in some quantities in fish weirs along the Maryland-Virginia coast, but today almost the

entire catch is taken incidentally in shrimp trawls. It is associated with brackish or low-salinity waters and is found primarily in bays and nearshore waters to a depth of 20 m (Rathjen et al. 1979).

Illex illecebrosus.—This is the short-finned squid, or "common" squid of Newfoundland. It has been the object of a traditional fishery in waters adjacent to Newfoundland where jigging remains the basic approach to squid harvesting. The species, at least one of three species or subspecies present in waters of the Northwest Atlantic, ranges from Newfoundland southward along the eastern coast of the U.S.A. to Florida and the Gulf of Mexico, and along the coast of South America (Voss 1971, 1973). In Newfoundland it occurs in waters of about 15–25 m on the squid fishing grounds, but in the warmer waters of the the tropical western Atlantic it lives at depths of about 180–450 m. Although this squid has been valued primarily as bait, its food quality is excellent. Off Newfoundland this squid first appears in June at a length of about 16 cm. It grows rapidly and in October the males average 23 cm and the females are about 25 cm. In late October and November the larger animals, approaching sexual maturity, begin to disappear from inshore waters.

Ommastrephes pteropus.—This is the "orangeback" squid found over the outer part of the continental shelf and in the open sea south from Nova Scotia through the Caribbean and the Gulf of Mexico to Brazil and across the Atlantic. It is easily brought to a boat's side at night with lights and could easily support a large fishery. It is a moderate to large squid, very heavy and meaty, and the supply seems nearly inexhaustible (Voss 1971, 1973). Okutani (1977) gives a size of 35 cm and states that this squid is known from waters 220–250 and is found at depths of 3,160 m to the surface.

Pholidoteuthis adami.—This species was first described by Voss in 1956. Voss examined 31 specimens ranging in sizes from 14.6 to 30.5 cm. It is found in the upper Gulf of Mexico, east of the Mississippi Delta, and off the coast of Texas. Voss has reported that schools of this squid appeared on the surface several hours after sunset, and that on occasions a school would swim past the ship for several hours. This species could be present in sufficient numbers to support a commercial fishery.

B. Western United States of America and Alaska

Numerous species of squid are found in waters off the west coast of the U.S.A., but only one is the object of a fishery. Experimental fishing in the North Pacific by the Northwest Alaska Fisheries Center (NWAFC)¹ revealed a number of species which might be of commercial importance. These are as follows:

¹Mercer, R. W. (editor). 1981. Proceedings of the Squid Workshop. Sponsored by the Resource Assessment and Conservation Division, Northwest and Alaska Fisheries Center, 19–20 March 1981, Seattle, Washington. Northwest Alaska Fish. Cent. Processed Rep. 81–11, 34 p. Northwest Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Seattle, WA 98112.

Loligo opalescens.—This species is presently taken commercially off California. It is a small squid with maximum mantle lengths of about 18 or 19 cm for females and males, respectively (Fields 1965). It is found from British Columbia to central Baja California. Adults congregate in vast numbers in shallow waters to spawn, primarily at depths of 15–35 m. Various estimates of the potential annual yield have been given, ranging from over 100,000 tons (Voss 1973) to 600,000 tons (Gulland 1970). The catch has averaged about 10,000 tons annually from 1970 through 1980.

Symplectoteuthis oualaniensis.—This is a medium-sized squid reaching 35 cm in length. It is an oceanic squid occurring throughout the tropical and subtropical waters of the Pacific and Indian Oceans. Off the west coast of the U.S.A. it occurs from off Oregon to Central America. This squid is plentiful and probably represents a very large potential. Voss (1973) speculates a potential of at least 100,000 tons in the central eastern Pacific. According to Voss, this squid is said to resemble the "surume-ika," Todarodes pacificus, of Japan and are often marketed as such there.

Dosidicus gigas.—This squid, often called the South American "giant" squid or Humboldt squid, ranges from California to Cape Horn with its major concentrations off Peru and the northern two-thirds of Chile. As an adult it attains a length of 2–3 m. In the younger stages (25–50 cm) they are often confused with S. oualaniensis of the same size (Voss 1973). A few tons have been landed in California from time to time but never in sufficient quantity to support a sustained fishery (Kato and Hardwick 1976).

Ommastrephes bartramii.—This is a medium-sized squid reaching 45 cm in length. It is an oceanic squid ranging from Alaska to Central America in the eastern Pacific, from north of the Aleutians to the Philippines in the western Pacific, and throughout the central Pacific north of the Equator (Okutani 1977). In 1978 this species comprised almost half of the squid catches taken in Japan's waters (Court 1980).

Onychoteuthis borealijaponicus.—This species reaches about 29 cm in length. It is an oceanic squid distributed continuously across the northern half of the North Pacific, northward from Taiwan in the west, and Baja California in the east. It is of occasional commercial importance in the Japanese squid fishery.

Berryteuthis magister.—This is a small, soft-bodied squid of about 22 cm. It is found off Japan, the Aleutian Islands, and along the coasts of Alaska, Canada, and Northwestern U.S.A. and has been taken at depths of 300 m. It has been taken in trawls and is fed upon by whales (Okutani 1977).

Other squid of the Family Gonatidae (which includes B. magister) that occur in the Bering Sea, along the Aleutian Islands, the coasts of Alaska, Canada, and northwestern U.S.A. and which are of potential

commercial importance are Gonatopsis borealis, Gonatus onyx, and G. fabricii (Laevastu and Fiscus 1978).²

III. STATUS OF THE UNITED STATES OF AMERICA SQUID FISHERIES

A. Northeastern Fishery

The U.S.A. fishermen have been landing squid in the northeastern coast since the 1880's but have never been aggressive in fishing for them. The catches have ranged from 0.9 to 6,000 tons between 1953 and 1979 (Table 1). Most of the squid have been taken incidental to fishing for other fish species in inshore grounds and the American fishermen have yet to fully exploit the offshore stocks. Perhaps the main cause of the low U.S.A. catches have been the lack of a substantial domestic market.

On the contrary, squid has long been a popular food fish in certain foreign markets and thus a highly sought marine resource by foreign fishing fleet. Foreign vessels began reporting incidental catches of squid off the northeastern coast in 1964, with directed fishing starting in 1968 (Lange and Sissenwine 1980). The combined foreign and U.S.A. catch rose rapidly in the next 5 years, reaching a peak of 56,768 tons in 1973 (Table 2). From 1972 to 1976 the combined fleet has taken an average of 52,500 tons per year, of which 45,600 tons were taken by foreign vessels. Since 1977, however, the annual catches by foreign vessels have declined somewhat to about 28,500 tons in 1978.

The U.S.A. landings in the northeastern fishery have remained relatively steady at 1,000-2,000 tons between 1963 and 1978, with the exception in 1976, when the catch exceeded 3,800 tons (Table 2). The fishery, which includes the New England, mid-Atlantic, and Chesapeake regions, catches well over 90% of all squids taken by the U.S.A. in the Atlantic Ocean and the Gulf of Mexico (Table 3).

Landings are composed mostly of Loligo pealei which make up 71% of the total catch. Illex illecebrosus, the principal species taken off Newfoundland where catches of nearly 100,000 tons have been reported in 1978 (Hurley 1980), is also found along the coasts of Maine and Massachusetts. The U.S.A. fishery for Illex is well below that for Loligo, although it equaled that of the latter species in 1977 (Table 4).

B. South Atlantic and Gulf of Mexico Fisheries

Only a small part of the U.S.A. squid catch comes from the southeastern region of the U.S.A. and the Gulf of Mexico (Table 3), where L. pealei and L. plei make up the bulk of the catch. Another species, Lolliguncula brevis, also enters into the catch. According to Voss (1973) L. brevis was originally taken in some quantities in fish weirs along the

²Laevastu, T., and C. Fiscus. 1978. Review of cephalopod resources in the eastern North Pacific. Northwest Alaska Fish. Cent. Processed Rep., 15 p. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Seattle, WA 98112.

Table 1.--U.S. squid landings (thousand metric tons).¹

Year	Atlantic	Pacific	Total
1950	1.1	2.1	3.2
1951	2.5	5.6	8.1
1952	0.9	1.7	2.6
1953	2.6	4.0	6.6
1954	1.6	3.7	5.3
1955	1.9	6.5	8.4
1956	1.4	8.8	10.2
1957	2.7	5.6	8.3
1958	2.0	3.4	5.4
1959	1.7	8.9	10.6
1960	1.6	1.2	2.8
1961	1.5	4.7	6.2
1962	2.2	4.3	6.5
1963	2.2	5.2	7.4
1964	1.0	7.4	8.4
1965	1.2	8.4	9.6
1966	1.2	8.6	9.8
1967	1.8	9.0	10.8
1968	1.7	11.5	13.2
1969	1.7	9.4	10.1
1970	1.0	11.2	11.2
1971	1.2	15.8	17.0
1972	1.3	9.1	10.4
1973	1.8	5.5	7.3
1974	2.4	10.6	13.0
1975	1.6	7.8	9.4
1976	3.8	9.2	13.0
1977	2.4	8.8	11.2
1978	1.6	17.0	18.6
1979	6.0	16.0	22.0

¹As reported in FAO. Yearbook of fishery statistics, catches and landings (1954-80).

Table 2.--Annual squid catches¹ (*L. pealei* and *L. illecebrosus*) in metric tons, 1963-78,
by country, from the Northwest Atlantic, Cape Hatteras, North Carolina,
to the Gulf of Maine (from Lange and Sissenwine 1980).

Year	Country ²															Total
	Bulg.	Can.	Cuba	Fra	FRG	GDR	Ire.	Italy	Japan	Pol.	Rom.	Spain	U.S.A.	U.S.S.R.	Mex. ³	
1963													2,104			2,104
1964													934		4	938
1965													1,153		177	1,330
1966													1,174		344	1,518
1967									7				1,251		1,411	2,669
1968			10						1,734				1,762		3,176	6,682
1969			1						7,711			566	1,461		1,340	11,079
1970						20			13,639			4,426	1,061		1,065	20,211
1971	90	1							10,602			6,770	1,182		6,138	24,783
1972	499		14	296	463			3,200	18,691		66	10,545	1,197		6,976	47,375
1973	410			820	1,641	313		3,165	15,526		150	14,932	1,635		8,977	56,768
1974	592	27						4,260	16,820		9	16,144	2,422		8,495	55,478
1975	205		151		27	898	4,745	4,274	13,985		48	9,902	1,728		8,928	51,727
1976	23	54	265		1,023	1,313	3,283	4,421	8,285		22	13,200	3,831		7,644	50,120
1977	60	20	34			9	23	4,185	12,690		888	13,438	2,112		8,010	41,469
1978								3,497	6,053		67	13,186	1,861		40	3,822
																28,526

¹1963-76--ICNAF (International Commission of the Northwest Atlantic Fisheries) Statistical Bulletins No. 13-26; 1977--ICNAF Summary Document No. 78/VI/28. Provisional Nominal Catches in the Northwest Atlantic, 1977; 1978--Preliminary, as reported to NMFS by foreign fisheries officials.

²Countries are: Bulgaria, Canada, Cuba, France, Federal Republic of Germany, German Democratic Republic, Ireland, Italy, Japan, Poland, Romania, Spain, United States of America, Union of Soviet Socialist Republics, and Mexico.

³Mexico did not fish in this area prior to U.S.A. extended jurisdiction.

Table 3.--Squid landings (in metric tons) by region, U.S. east coast and Gulf of Mexico.¹

Year	New England	Mid-Atlantic	Cheasapeake	South Atlantic	Gulf of Mexico	Total
1960	948	549	137	7	14	1,655
1961	554	801	158	14	14	1,541
1962	1,124	907	116	12	27	2,186
1963	1,217	757	132	14	33	2,153
1964	252	628	61	20	21	982
1965	381	647	116	16	24	1,184
1966	237	752	193	16	28	1,226
1967	825	632	265	19	22	1,763
1968	836	626	202	21	40	1,725
1969	875	411	176	13	26	1,501
1970	497	343	196	12	25	1,073
1971	802	234	191	9	23	1,259
1972	656	533	121	10	10	1,330
1973	1,164	509	79	20	21	1,793
1974	1,289	1,021	106	47	30	2,493
1975	1,196	685	64	42	20	2,007
1976	2,833	900	69	24	33	3,859

¹As reported in U.S. National Marine Fisheries Service. Fishery statistics of the United States (1962-80).

Table 4.--Squid catches (in tons), by species,¹ year, and country, from the Northwest Atlantic, Cape Hatteras to the Gulf of Maine, 1963-78 (from Lange and Sissenwine 1980).

Year	Country ²															Total
	Bulg.	Can.	Cuba	Fra.	FRG	GDR	Ire.	Italy	Japan	Pol.	Rom.	Spain	U.S.A.	U.S.S.R.	Mex. ³	
Long-finned squid																
1963													1,294			1,294
1964													576	2		578
1965													709	99		808
1966													722	226		948
1967									5				547	1,125		1,677
1968									177				1,084	2,150		3,411
1969									7,125			438	899	1,080		9,542
1970									13,250			2,790	653	692		17,385
1971	10								10,426			3,446	727	3,560		18,169
1972	20			288	463			2,000	16,293	164	66	5,667	725	4,048		29,734
1973	46			793	1,641			2,360	14,459	911	150	11,148	1,105	5,000		37,613
1974	172	27						3,280	13,493	1,706	3	9,375	2,274	4,520		34,850
1975	34		30		27	16	1,660	3,390	10,748	3,785		7,698	1,621	4,792		33,801
1976	23		257		22	317	1,042	3,304	5,029	1,706	13	9,137	3,602	832		25,284
1977	8	15	28			9		2,237	7,814	232		5,236	1,088	7		16,674
1978								1,366	2,309		17	4,603	1,476	7	1,053	10,831

Long-finned squid

Table 4.--Continued.

Year	Country ²													Total		
	Bulg.	Can.	Cuba	Fra.	FRG	GDR	Ire.	Italy	Japan	Pol.	Rom.	Spain	U.S.A.		U.S.S.R.	Mex. 3
Short-finned squid																
1963													810			810
1964													358		2	360
1965													444		78	522
1966													452		118	570
1967									2				707		286	995
1968			10						1,557				678		1,026	3,271
1969			1						586			128	562		260	1,537
1970						20			389			1,636	408		373	2,826
1971	80	1							176			3,325	455		2,578	6,614
1972	479		14	8				1,200	2,398	5,264		4,878	472		2,928	17,641
1973	364			27		313		805	1,067	8,288		3,784	530		3,977	19,155
1974	420							980	3,327	5,003	6	6,769	148		3,975	20,628
1975	171		121			882	3,085	884	3,237	3,051	48	2,204	107		4,136	17,926
1976		54	8		1,101	996	2,241	1,117	3,256	5,050	9	4,063	229		6,812	24,936
1977	52	5	6				23	1,948	4,876	656		8,202	1,024		8,003	24,795
1978								2,131	3,744		50	8,583	385		33	2,769 17,695

¹1963-66--estimated breakdown of total squid catch, prorated by ratio of reported L. pealei to L. illecebrosus, from ICNAF Statistical Bulletins No. 13-16; 1967-76--ICNAF Summary Document No. 78/VI/6; 1977--ICNAF Summary Document No. 78/VI/28; 1978--Preliminary, as reported to NMFS by foreign nations.

²Countries are: Bulgaria, Canada, Cuba, France, Federal Republic of Germany, German Democratic Republic, Ireland, Italy, Japan, Poland, Romania, Spain, United States of America, Union of Soviet Socialist Republics, and Mexico.

³Mexico did not fish in this area prior to U.S.A. extended jurisdiction.

Maryland-Virginia coast. More recently, however, almost the entire catch has been taken incidentally in shrimp trawls. Areas of prevalence were reported as Georgia-north Florida, west Florida, and the upper Gulf of Mexico. There are no estimates of catch or availability for this species as most landings are grouped under "squid" and are not separated by species. Rathjen et al. (1979) report that most squid landings in the northwestern gulf consist of incidental catches of "white" squid, L. brevis, in the bay and nearshore trawl fishery for white shrimp, and that few "red" squid, Loligo plei and L. pealei, are caught by the offshore brown shrimp fishery.

C. West Coast Fishery

Practically the total squid production of the U.S.A. west coast, including Alaska, comes from the California fishery for the common market squid, Loligo opalescens. A few tons of the jumbo squid, Dosidicus gigas, have been landed from time to time but never in sufficient quantity to support a sustained fishery. Most other species are either too small or not readily available to the fisheries (Kato and Hardwick 1976). The landings of squid in the Pacific have fluctuated from 1,200 to 9,000 tons in the 1950-67 period, but have averaged 11,000 tons over the last 12 years, 1968-79 (Table 1). While the landings were significantly higher than in the eastern U.S.A., they were insignificant when compared with the world squid landings, which averaged well over 820,000 tons over the 1968-79 period (FAO 1954-80).

The California squid fishery is essentially two fisheries, one centered at Monterey and the other in southern California at the Channel Islands, seaward from the Los Angeles area (Kato and Hardwick 1976). The landings at Monterey have generally remained between 3,000 and 6,000 tons annually from 1963 through 1974, with a high of over 9,000 tons in 1971 and a low of 563 tons in 1973 (Table 5). In 1975 and 1976 the landings were slightly above 2,000 tons, well below the average. Some constraints were placed on the Monterey fishery by the State of California when it outlawed the use of purse seines in Monterey Bay in 1953 to prevent the net from uprooting and damaging the sessile spawned squid eggs. Spawning occurs there in shallow waters and the lead line of the seines often reached the bottom during sets. Another law introduced in 1959, which limited fishing activity in the bay, banned the use of lights to attract squids. This effectively excluded the use of brailing and pumping methods of capturing squids (Kato and Hardwick 1976). In the southern California fishery the landings have increased from a low of 148 tons in 1960 to 7,200 tons in 1970, and have fluctuated between 3,000 and 8,500 tons from 1971 to 1976. Thus, except for the years 1973, 1975, and 1976, the Monterey and southern California fisheries have remained about equally productive, despite the restrictions placed on the use of purse seines and squid attraction lights in Monterey Bay.

IV. FISHING METHODS AND GEAR

Squids are taken in U.S.A. waters by a variety of methods and gear, including purse seine, lampara nets, otter trawls, pound nets, floating

Table 5.--Squid landings (in metric tons) in the
California fishery.¹

Year	Monterey	Southern California	Total
1960	1,014	147	1,162
1961	1,672	2,994	4,666
1962	2,564	1,685	4,249
1963	3,064	2,180	5,244
1964	4,128	3,326	7,454
1965	4,021	4,425	8,446
1966	5,084	3,546	8,630
1967	5,095	3,796	8,891
1968	6,613	4,697	11,310
1969	5,344	4,182	9,426
1970	3,913	7,241	11,154
1971	9,248	6,745	15,993
1972	5,560	3,584	9,144
1973	563	4,938	5,501
1974	6,575	6,536	13,111
1975	2,263	8,469	10,732
1976	2,278	6,947	9,225

¹As reported in U.S. National Marine Fisheries Service.
Fishery statistics of the United States (1962-80).

traps, handlines, gill and trammel nets, and dip, brail, or scoop nets. The varieties of gear employed differ somewhat from region to region.

In the northeastern fishery, the bulk of the annual catch (about 85%) is made in otter trawls as incidental catches in the bottom fish fishery, about 10% in pound nets, and roughly 5% in floating traps. In some years the otter trawl catch comprises 95% of the total catch, while in others the pound net catch exceeds 18%. In addition to these, purse seines, handlines, and midwater trawls are used in some years; however, the catches from these gear are insignificant, well below 1%. A breakdown of the catch in 1976 shows that 0.3 ton of squid were taken in purse seines, 3,858 tons in bottom fish trawls, 382 tons in pound nets, 252 tons in floating traps, and 4.5 tons in midwater trawls (U.S. National Marine Fisheries Service (NMFS) 1980).

Other means of catching squids have been tried in the area in recent years. In 1973-75 the Japanese conducted exploratory fishing between Cape Hatteras and the Grand Banks by sending a vessel equipped with squid jigging machines. Fishing south of Georges Bank along the edge of the continental shelf yielded 103 tons of Illex illecebrosus in 112 days of fishing in 1973 and 1974 (Ichikawa and Sato 1976). In 1979 two Polish vessels also equipped with squid jigging machines conducted exploratory fishing southeast of Cape Cod (Long and Rathjen 1980). One vessel caught 32 tons of Illex in 15 days of fishing, an average of 2.1 tons per day, and the other caught 31.3 tons in 11 days, an average of 2.8 tons per day.

In the southeastern and gulf fisheries, nearly all of the squids are taken as incidental catches in shrimp trawls.

In the west coast southern California fishery the bulk of the squid catch is made with purse seines and power-assisted brail, used in conjunction with squid-attracting lights (Kato and Hardwick 1976). No special seines are used for squids, but the anchovy and mackerel seines are employed whenever the opportunity arises. In most years 80-95% of the catch is made with purse seines but in some years the catch with brail, scoop, or dip nets comprise 56-66% of the total annual catch (NMFS 1980).

Kato (1970) developed a unique method of catching squid with a hydraulic centrifugal pump. While only one fisherman has used the pump successfully, the method appeared promising. During the 1973-74 season the vessel, using the fish pump as well as the brailing method, caught 710 tons of squid in 43 delivery days for an average of 16.7 tons per day (Kato and Hardwick 1976). The range in catch per night varied from under a ton to 54 tons. The authors also reported that catches of 75-85 tons had been made with the pump in 1 night's fishing by this same vessel in prior years.

The catch in Monterey is made almost entirely with lampara nets. Occasionally squids are caught in traps and on lines but the catches comprise less than 0.5% of the total annual landings. Scoop or dip nets are used frequently with catches comprising less than 3% of the total catch. In most years the catch by scoop or dip nets does not exceed 1% of the total catch (NMFS 1980).

V. UTILIZATION OF CATCH

Until 1973 about 75% of the catch in the northeastern and mid-Atlantic fisheries was sold to the fresh market or used as bait, but since then more of the catch has been frozen and exported to European countries. Some of the catch has been canned since 1958 with the operation of a cannery in New York in 1958 and another in New Jersey in 1959 (Power 1960, 1961). The only commercially prepared squid product produced in the U.S.A. is squid canned with or without its ink in brine, in oil, and in tomato sauce (Ampola 1974).

In California the squid catch is canned or frozen and exported to European markets, Latin American countries, and to the Orient, particularly the Philippines. Domestic consumption is mostly in frozen form, and a considerable amount of frozen squid is also used as bait in both commercial and recreational fisheries. Squid taken by commercial vessels are usually sold to freezer plants first because of the higher price, and the canners receive the excess beyond the processing capacity of the freezer plants. Thus, in times of high availability, more squid is canned (Kato and Hardwick 1976). Squid has been canned in California for many years. In 1948, 20 canning plants produced 349,800 cases from 7,632 tons of squid. The number of canneries fluctuated greatly but has remained at about 6 in recent years.

In 1976, the latest year for which published data are available (NMFS 1980), the U.S.A. canned 3,302 tons of squid, producing 151,333 cases valued at \$1,725,000, with eight canneries in operation, two on the east coast and six in California. A total of 2,784 tons of squid were frozen, with the breakdown by regions as follows: Northeast - 1,361 tons; mid-Atlantic - 96 tons; south Atlantic - 81 tons; and California - 1,245 tons. Fresh and frozen squid used for industrial products included 158 tons for animal food and 1,495 tons for bait.

American consumer demand for squid traditionally has been low, with domestic consumption limited primarily to sales of fresh and frozen squid to ethnic groups in certain metropolitan areas. Recently squid has gained some popularity as an entrée in California restaurants (Ampola 1974) and a study designed to assess market potential in New England has been started (Rathjen 1977), but neither development has yet had a large impact on consumer patterns. Possible opportunities may exist for specialty convenience-type packs to be offered to the mass consumer or the "fast-food" market area, and in domestic use in seafood chowders or as a partial replacement for certain other shellfish, i.e., clams in chowders, soups or other preparations (Rathjen et al. 1977).

Hixon et al. (1980) suggest two domestic marketing approaches to be considered at this time. "One is through the larger-scale consumer and restaurant trade route, and the other is to introduce the product on a small scale as specialty items in local seafood or ethnic restaurants. The first approach requires relatively complex and extensive channels of distribution that must first be developed to insure wide market acceptance. To overcome consumer unfamiliarity with squid and gain mass market

acceptance, a well-coordinated promotion program by large seafood processors or a restaurant chain must be instituted.

"The second marketing approach seems more appropriate at this time. Small-scale introduction seems best done initially by small processors who could introduce processed squid specialty items such as stuffed squid or breaded squid rings and strips to local small markets, including certain urban ethnic populations which are familiar with squid, and coastal areas or seafood restaurants where one might expect to find squid as a menu item. Once squid has gained public awareness and acceptance on this small scale, steps may be taken toward the development of mass market acceptance."

VI. DATA COLLECTED

Data on squid may be found in several publications: FAO Yearbook of Fishery Statistics, Fishery Statistics of the United States, ICNAF Statistical Bulletin, California Marine Fish Landings, and Fish Landings Statistics of Other Coastal States. The first four sources provide coverage of the areas where squid are presently taken. The FAO Yearbook and the ICNAF Bulletin list the squid by individual species. However, because not all countries report catch by species, a category of a larger taxonomic group is also included. A description of each publication and the types of data presented are summarized below.

FAO Yearbook of Fishery Statistics.—Squid landings or catches are reported by species, major fishing areas, and country. The major squid species are indicated but because not all countries report catch by species a category of combined families is included. The listing by species first appeared in the statistics for 1971. The data are published annually with a time lag of 1 year.

Fishery Statistics of the United States.—Squid data are reported in various forms: Landings of species by region with corresponding dollar values; landings of species by state and region; landings of species by gear, state and region; landings of species by distance caught off U.S. shores and in international waters; and landings used for industrial products by region. Also reported are summaries of quantity and value of processed fishery products (canned), freezing by month and region, and U.S. exports of domestic products. Species breakdown apply largely to fish and crustaceans and are given in common names. Squid are all grouped under one heading - squid. The data are published annually with a time lag of 4 years.

ICNAF Statistical Bulletin.—The Bulletin, which is issued annually by the International Commission for the Northwest Atlantic Fisheries, is based on statistics of fishing effort and nominal catches for the Northwest Atlantic (FAO Major Fishing Area 21), as reported by member countries of the Commission. Data for nonmember countries are included as they become available. Statistical reports were received from 20 countries for the year 1978. Squid catches are presented in various ways: (1) by species and subarea (see Fig. 1 for subdivisions of area); (2) by species groups by division and country; (3) by individual species by division and country;

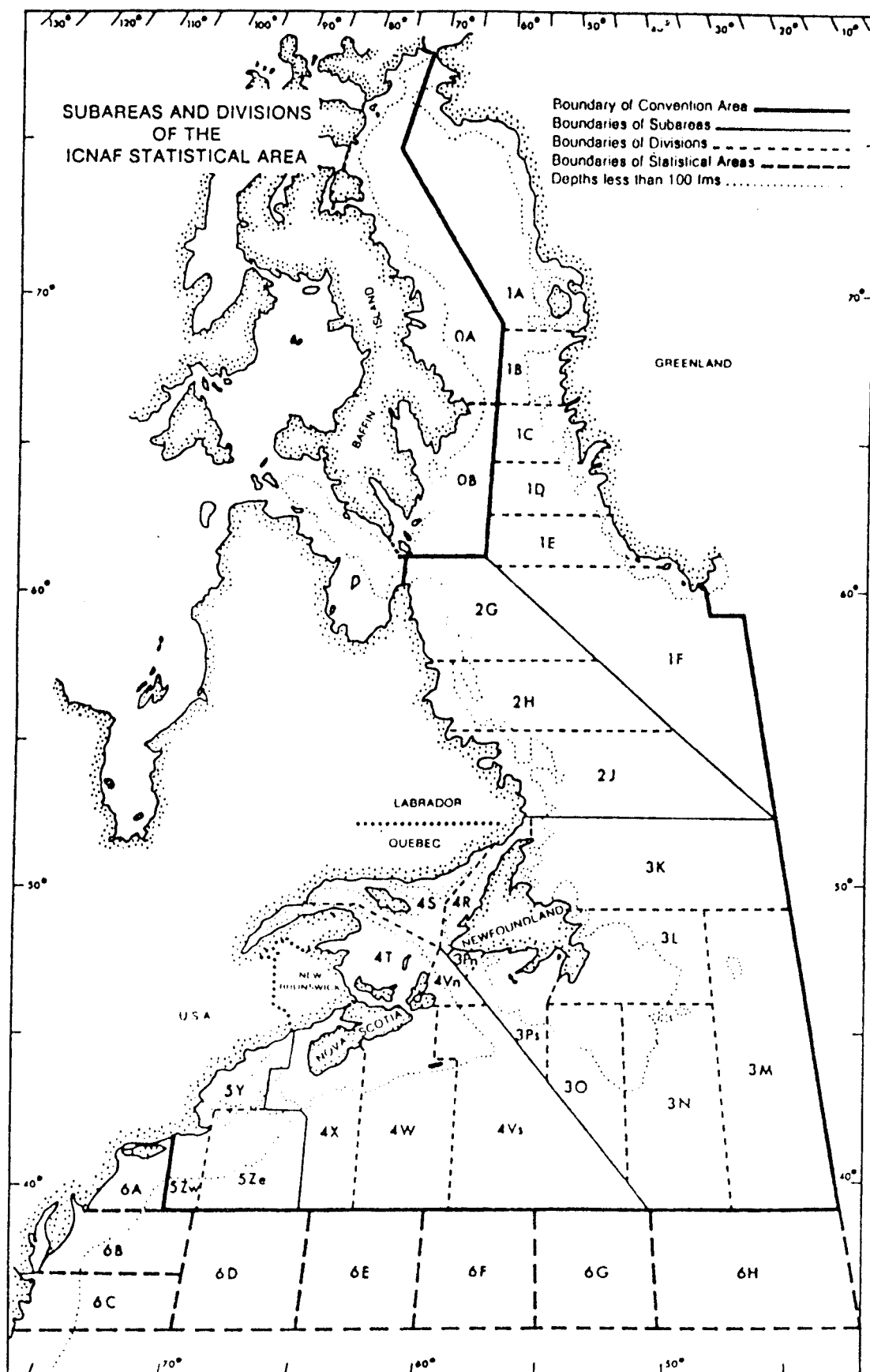


Figure 1.--Subareas and divisions of the ICNAF statistical area.

(4) by selected species by division, country, and month; (5) fishing effort and catches by division, month, gear, main species, vessel tonnage class, and country; (6) summary of catches and fishing effort for each country by gear, vessel tonnage class, and subarea; and (7) catch and effort statistics for countries whose vessels fished in the Northwest Atlantic under cooperative arrangements with Canada. Time lag for the published report is 2 years.

California Marine Fish Landings.—Squid catches are reported as (1) annual landings from California waters, (2) monthly landings of commercial boats by area, (3) value of landings and shipments into California by area, (4) weight and value of landings by port and area, and (5) catch of live bait for sport fishing. Statistics are published annually with a time lag of 2-3 years since 1971. Squid are listed as "squid, common market" (= L. opalescens).

Much of the recent studies on squids off the Northeastern United States of America and Canada have come from the ICNAF area, nearly all concerning the two species (L. pealei and I. illecebrosus) taken in large quantities commercially. These studies include such areas as abundance, age and growth, growth and life cycle, distribution and biological characteristics, length-weight relationships, maturation and fecundity, biomass estimates based on catch and catch rates, stock assessment based on commercial trawl catches, and biological considerations relevant to the management of the fishery based on data collected from commercial and research vessels.

In the Southeastern U.S.A. species composition, distribution and abundance of squids common to the area are being investigated from data collected from Marine Resources Monitoring, Assessment, and Prediction (MARMAP) trawl surveys (Whitaker 1980). In the northeastern Pacific species composition and other biological information on squid are being obtained from samples and data collected from stomachs of seabirds and the northern fur seal and from the Northwest and Alaska Fisheries Center's high seas drift gill net sampling program.

VII. ASSESSMENT OF RESOURCE

Voss (1973) stated that probably less than 10% of the world's ocean surface is at present being fished for cephalopods, i.e., that part of the ocean from the middle of the continental slope to the shoreline, and that probably 99% of all of our present catch is taken from this area. Thus about 90% of the ocean's area is unexploited. Yet this is the home of very large numbers of species of cephalopods that seldom stray inshore but spend their entire life cycle in the high seas.

Attempts to assess the potential productivity of squid in the oceanic area have largely been done on the basis of the amount of squid consumed by the sperm whale. Boerema (1970:cited by Voss 1973, but not included in his list of "References") has considered that the estimated 50,000 sperm whales off Peru consume about 1.46 million tons of squid annually (about 30 tons annual consumption per whale). Clarke (1977), by taking 1.2 million as the

total population of sperm whales, using 15 tons and 5 tons as the mean weights of males and females, respectively, and estimating the food consumption of 2% of body weight per day by males and 3% by females, derived a "conservative" estimate of at least 100 million tons of squid eaten in 1972. Further, by accepting a value of 15 tons for the average whale and a consumption of 3.5% of body weights per day, as well as an average calorific value of 75% of that for muscular squids, he estimated the amount eaten as 320 million tons. Based on Boerema's and other estimates gathered from various sources, including those by Clarke through personal communication, Voss (1973) gave the potential estimates of squid from the continental shelf fisheries in the Northwest Atlantic as 500,000 tons, and in the Northeast Pacific (waters off North America) as 600,000 tons.

Laevastu and Fiscus (see footnote 2) attempted a conservative estimate of squid consumed in the North Pacific with the following numbers: number of sperm whales - 150,000; average weight - 15 tons; average food requirement - 4% of body weight daily, of which 90% are squid. Thus, they estimated that the North Pacific sperm whales would consume about 30 million tons of squid annually. Further, nearly all pelagic marine mammals, including other whales, feed to some extent on squid, and smaller squid are eaten by all larger pelagic fishes and some species of marine birds. Thus, the marine ecosystem in the North Pacific was estimated to consume about 200 million tons of squid annually as food.

At the present state of knowledge of the squid fisheries, with usable data lacking on egg production and distribution, growth, longevity, stock sizes of most species and incomplete reporting of catch and effort data from many regions, it is difficult to give any reality to the potential estimates given above. The potential, nevertheless, appears quite promising.

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